

U.S. HiLumi Project

MATERIAL NAMING SCHEME

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|---|-----------------------------|--|
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Revision History

| Rev. | Date | Description | Section | Author |
|---------|------------|-----------------------------------|-------------------|----------------------|
| DRAFTv0 | 2015 02 26 | Original draft. | All | I. Pong L. Cooley |
| v1.0 | 2015 05 27 | Finalized §§5, 7, 8, and Appendix | 5, 7, 8, Appendix | I. Pong |
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1 SCOPE AND PURPOSE OF THIS DOCUMENT

The US-HiLumi project will construct superconducting magnets for the upgrade of the LHC. Magnets require flat “Rutherford” cables wound from 40 Nb₃Sn wires. This document is applicable to all strands, cables, and strand samples used by US-HiLumi.

This document describes a system using 14 characters (plus a 4-character extension) to identify all strand spools, cables, and samples. The identifications are based on the schema originally devised by CERN as described in the document ‘Material Accounting in TE-MS-SCD Laboratory v.6’. The schemes herein uniquely label strand and cable pieces, as well as uniquely identify samples obtained from strands or cables. The 14 alpha-numeric-character sequence that identifies a virgin strand spool for LARP is intended to be fully compatible with the ID Code Scheme used at CERN. The 14 alpha-numeric character sequence for cables has also been developed with cross-compatibility in mind. (The sequence up to the 9th character in the US-HiLumi code is fully compatible to CERN’s 9-character cable code.) The 14-character suffix ‘Sample-HT-Test ID’ is a system invented at LBNL and adopted by US-HiLumi.

2 REQUIRED REFERENCES

US-HiLumi-doc-36 *MQXFA Functional Requirements Specification*

US-HiLumi-doc-37 *Conductor Acquisition Plan*

3 TERMINOLOGY

The following terms have specific meaning in this document and in reference to US-HiLumi strands, cables, and samples:

billet

- the entire assembly of components intended to become a single continuous length of strand if successfully drawn without breaks. It defines the architecture and the wire design.

piece

- a continuous length of strand, typically many hundreds of meters long at final diameter.

stability zone

- the region of stable manufacture of strand lengths with high repeatability. The stability zone *excludes* (i) startup lengths over which process controls acquire stability, (ii) locations near breaks, and (iii) any run-out lengths where such controls are released. The diagram in Figure 1 illustrates schematically the different pieces expected from a billet and the locations of stability zones and zones that are not stable. The nomenclature ‘P’, ‘X’, ‘Y’, and ‘T’ label the boundaries of production pieces and also identify the wire drawing direction.

strand production unit

- materials from a common billet which have undergone identical mechanical and thermal processing. If there was no breakage down to the final diameter, it would typically be a

very long ($\gg 1$ km) and continuous strand piece taken only from the stability zone during manufacturing.

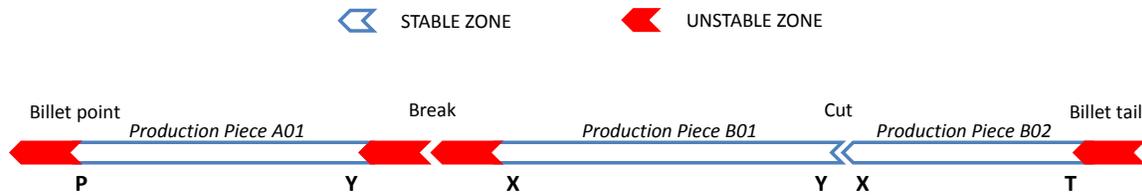


Figure 1 Diagram of different pieces that might be obtained from a strand billet with a break and an intentional cut. The labels “P”, “X”, “Y”, and “T” define locations relative to the direction of wire drawing for each piece.

cable production unit

- a continuous and long, typically > 100 m, length of cable with the same cable map intended for coil or magnet construction.

Note: *piece length, strand piece length, production piece length, production length, strand length, and cable production length* can each refer to the length of the piece of strand or cable, or to the piece itself as a length of strand or a length of cable. To avoid ambiguity, these terms are not used in this document.

unit length

- or (cable) UL. The length of cable required to wind a magnet. The length of the cable production unit may often be an integer multiple of the unit length.

virgin strand

- strand in the original as-manufactured state.

extracted strand

- strand unwound and separated from a length of cable.

archive sample

- a length of strand, typically 10 to 20 m long, cut from a strand production unit and set aside for future use. Or, a length of cable, typically 5 m or longer, cut from a cable production unit and set aside for future use.

short sample

- a length of strand, typically a few centimeters to a few meters long, intended for testing. A short sample is typically cut from either an archive sample or a strand piece.

point

- the front end of the first (or only) piece of strand made from a billet, relative to the direction of wire drawing and the sequence of any breaks that may have occurred. In case of a cable, the front end direction is the one that went through the Turks head first.

tail

- the back end of the last (or only) piece of strand made from a billet, relative to the direction of wire drawing and the sequence of any breaks that may have occurred. In case of a cable, the back end direction that exited the Turks head last.

fork

- the “U” shaped fixture that supports the axle through a spool of wire and other components (e.g. spool brake) on a cabling machine. Cabling machines may have a single bay or multiple bays. A bay rotates as a unit and is fitted with many forks to accommodate spools or spindles of strands. Each fork may be rotating about its own axis and revolving about the bay’s axis in a planetary motion.

heat treatment

- or reaction heat treatment. A particular sequence of temperatures and times intended to produce reactions between components contained within the superconducting wire, such as the reaction of niobium with tin to produce the compound Nb₃Sn.

anneal

- a particular type of heat treatment that is intended to change the physical or electrical properties of the wire, but not produce reactions of any kind. Annealing usually has an impact on the degree of spring back in a wire and on the residual twist in a cable.

pull-out

- the removal of a strand specimen from the furnace during a reaction heat treatment, which is intended to interrupt the reaction process at a certain stage of completion. Pull-out samples are generally intended to study or monitor the reaction process.

4 NAMING SCHEME FOR VIRGIN STRAND

The naming scheme for virgin strands is outlined in Table 1.

Table 1 Overview of the naming scheme for virgin strands

| | | | | | | | | |
|------------------------|---|---|----|---|-------|---|----|---|
| Name → | A | A | 99 | A | 99999 | A | 99 | A |
| Project Code | | | | | | | | |
| Supplier Code | | | | | | | | |
| Rough Diameter | | | | | | | | |
| Material Code | | | | | | | | |
| billet Number | | | | | | | | |
| strand production unit | | | | | | | | |
| piece Number | | | | | | | | |
| Coating Code | | | | | | | | |

Note: '9' in the scheme is used as a placeholder for a digit and 'A' as a placeholder for a letter.

4.1 Project Code

Project code is a unique one-letter code. The code 'P' is reserved for LARP/US-HiLumi in the CERN ID Code Scheme, and 'H' is reserved for CERN's High Field Magnet program in the LARP/US-HiLumi ID Code Scheme. 'A' is reserved for HiLumi LHC (CERN).

4.2 Supplier Code

Supplier code is a unique one letter code that identifies the strand suppliers who have been offered contracts from either CERN or US-HiLumi. The letter shall be selected from the list of supplier codes agreed with CERN listed in §A.1.

4.3 Rough Diameter

Rough diameter is the strand diameter in tenth parts of millimeter and truncated (not rounded) to tenth part of millimeter. *Example: 12 for 1.20 mm up to 1.29 mm, 08 for 0.80 mm up to 0.89 mm.* For rectangular wires and tapes, rough strand thickness should be used instead of rough diameter.

4.4 Material Code

Material code is a unique one letter code for the primary superconducting material in strand ID. US-HiLumi uses only Nb₃Sn strand, with code designation 'S'. Note: The designation 'S' does not differentiate different strand types such as bronze process, internal tin process, restacked rod process (RRP®), etc.

4.5 billet Number (or Serial Number)

A five-digit number has to be given to uniquely identify material of one billet. The number shall be padded by leading zeroes if necessary, e.g. '00293'.

4.6 strand production unit

The strand production unit identifier consists of one letter. The code identifies material from a common multifilament billet which undergoes identical mechanical and thermal processing. Breakages during drawing will invoke a different letter. Likewise a single piece cut into two at intermediate diameter which are drawn down to final diameter separately will be considered as two separate strand production units.

4.7 piece Number

The piece number is a two-digit number assigned to identify the strand pieces from the same strand production unit. piece numbers shall be sequential from '01', from the billet point to the billet tail, re-starting the sequence for different strand production units. Different pieces resulted from cutting may have the same strand production unit code only if they have identical mechanical and thermal processing.

4.8 Coating and Annealing Code

Coating code is a unique one letter code for coating metal or coating absence designation in the strand ID. The selection of letter also designates the presence of an annealed condition. US-HiLumi uses only un-coated strands, with code designation 'U' for un-annealed and un-coated strands, and 'A' for annealed and un-coated strands.

5 NAMING SCHEME FOR ARCHIVE AND VERIFICATION PIECES

Pieces of 10 to 20 m length are routinely cut from strand production units to set aside material for certification and QC samples at the supplier, for verification and QC samples at reference labs, for archives, and for laboratory or facility qualification. Such pieces are identified by an extension added to the strand identifier, as listed in Table 2. Each identifier group is discussed in the sub-sections below.

Table 2 Appendix to strand name to identify QA, QC, archive, and other lengths

| | |
|-----------------|-------------------------|
| Name → | AA99A99999A99A . A A 99 |
| Strand Code | |
| (decimal point) | |
| point/tail Code | |
| Use Code | |
| Sequence | |

5.1 point/tail Code

The location shall be the letter ‘P’, ‘X’, ‘Y’, or ‘T’ denoting the billet location where the piece was cut, as defined below and illustrated in Figure 1:

- P - sample cut from the point extremity of the billet,
- T - sample cut from the tail extremity of the billet,
- X - sample cut from the point side of a piece in the billet, but not from the point extremity of the billet,
- Y - sample cut from the tail side of a piece in the billet, but not from the tail extremity of the billet.

5.2 Use Code

The purpose shall be a letter designating the disposition of the sample. For example, it may become customary for a worker at the supplier to cut 3 lengths at the same time from a strand production unit, requiring an identifier to assist in routing and to avoid handling errors due to identical names (due to the same strand spool) if this letter was absent. The following table describes the uses for US-HiLumi:

| <u>Use Code</u> | <u>Description</u> |
|-----------------|---|
| A | Archive length intended for storage |
| V | Verification use and QC |
| S | Supplier use, including supplier sub-contractors |
| O | Other purpose, such as university R&D, facility qualification, etc. |

5.3 Sequence

The sample sequence is a 2-digit number to facilitate routing when multiple pieces are cut. The recommendation is to use an incremental first digit (e.g. “10”, “20”, etc.) when cut directly from a

spool where the number of cuts should be recorded, and to use an incremental second digit (e.g. “11”, “12”, “21”, “22”, etc.) for subsequent cuts off those piece.

This sequence shall be applied to samples prior to heat treatment. An exception is a long barrel sample mounted on a heat treatment mandrel *intended* to be sectioned for re-mounting on barrels for I_c tests. As this cut is fully intended, the sequence code should include the new piece at the time of the initial cut and prior to the post-HT cutting (i.e. skipping the intended number).

6 NAMING SCHEME FOR CABLES, CABLE SAMPLES, OR EXTRACTED STRANDS

An overview of the naming scheme is given in Table 3.

Table 3 Overview of the naming scheme for cables, cable samples, and strands from cables.

| | | | | | | | | | |
|-------------------------|---|----|---|---|------|-----|---|----|---|
| Name → | A | 99 | A | A | 9999 | A/9 | A | 99 | A |
| Project Code | | | | | | | | | |
| Cable Code | | | | | | | | | |
| Supplier Code | | | | | | | | | |
| Cable Manufacturer Code | | | | | | | | | |
| Cable Map Number | | | | | | | | | |
| Cable Production Piece | | | | | | | | | |
| 100m Code | | | | | | | | | |
| Fork ID or 1m Code | | | | | | | | | |
| Type Code | | | | | | | | | |

Note that a ‘family’ of cables may be referred to using the first 9 digits (i.e. up to the Cable Map Number).

6.1 Project Code

Project code shall be as defined in §4.1 above.

6.2 Cable Code

The cable code shall be selected from the table in §A.2 Cable Code. If the code has not yet been assigned for a new cable run, then the run shall not begin until the new entry has been approved in the database.

6.3 Strand Supplier Code

Strand supplier code shall be as defined in §4.2 above.

6.4 Cable Manufacturer Code

The list below is relevant to US-HiLumi only, the full list can be found in §A.3 Cable Manufacturer Code.

| | |
|------|--------------------------------------|
| Code | Cable Manufacturer |
| C | CERN |
| N | NEWT – New England Wire Technologies |
| L | LBNL |

6.5 Cable Map Number

Cable map number is assigned by the cable manufacturer. If the wire spools or core spools are changed, it will be a different cable map. Note: a separate ‘spool map’ has to be kept to identify the position of the strands within the cable.

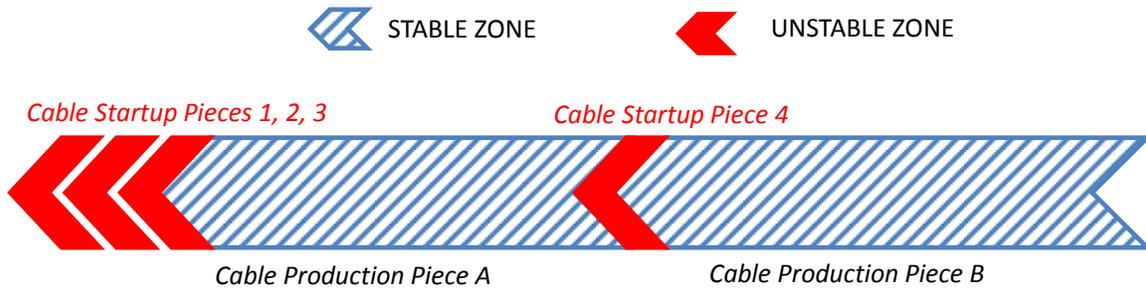


Figure 2 Schematic of a cable production run, showing startup pieces and production pieces.

6.6 cable production unit

Multiple runs are possible from a single map. Startup runs are numbered (i.e. 1, 2, 3...) and production runs, with stable parameters, are identified by the corresponding letter (i.e. 'A' for the 1st production code), as indicated in Figure 2. A cable production unit identifier should denote the same continuous cable run with identical nominal cabling parameters. The front or point end of the production length shall be labeled.

6.7 100m Code

The length of the cable piece produced during production is recorded in the cable identifier. The identifier is composed of a letter, since the length of a cable production unit can exceed 1 km but not 2.6 km. Here 'A' denotes a piece starting at 0 to 99 m, 'B' starting at 100-199 m, ..., 'J' for 1000-1099 m, etc.

Production pieces are sometimes cut to remove a short cable piece as a sample. It is also possible to extract a strand sample from this short piece of cable. In either case, the cable sample pieces will be identified by the position of the point-end cut, truncated to the closest 100 m, from the point end of the cable production unit (see 6.8 below). The identifier is composed of the same letter scheme above.

6.8 Fork ID or 1m Code

This code is a two-digit number. When the length of a cable production unit is identified, or a cable sample piece is cut, these digits identify the cable position to the nearest meter, in combination with the 100m Code above. For example a cable sample piece cut at 265 m from the cable point will receive the digits '65' for this code, along with the letter 'C' from 6.7 above.

A cable sample piece can be used as the source for extracted strand sample pieces (see 6.9 below). When a strand is extracted from the cable piece, these digits identify the fork position number on the planetary cabling machine that corresponds to the particular strand. Note that the fork position number may not correspond to the strand position in the cable, e.g. if a 40-strand cable is made from a cabling machine with 60 forks.

6.9 Type Code

The type code identifies what kind of cable as follows:

| <u>Code</u> | <u>Description</u> |
|-------------|-------------------------------|
| A | bare cable |
| B | cable with braided insulation |

T cable with wound tape insulation

For strands identified with cables, the type identifier shall be:

| <u>Code</u> | <u>Description</u> |
|-------------|--|
| E | extracted strand |
| V | virgin strand, e.g. excess attached to the cable at the end of the run |
| S | stainless steel core |

6.10 A Note on Strands

An extracted strand's detail (e.g. manufacturer, material, billet number etc.) will be identified via the cable map, and should be represented using the cable code in the form of A99AA9999AA99E where E stands for extracted strands.

A virgin strand attached to the cable at the end of the cabling run would be archived under A99AA9999AA99V using the protocol in this section, but the same strand could be archived under its applicable strand code in the form of AA99A99999A99A. Both identifiers will be recorded, cross-referenced, searchable, and barcode printed. The spool map provides the cross-reference links.

Likewise, the stainless steel core in a cable can be identified by its own identifier or in the form of A99AA9999AA99S where S stands for stainless steel core.

7 NAMING SCHEME FOR TEST SAMPLES

An overview of the test sample naming scheme is given in Table 4. This 14-digit code attaches to the Strand ID (for tests conducted on virgin strands) or Cable ID (for tests conducted on cables or extracted strands) and contains three parts: ‘Preparation’, ‘heat treatment/anneal’, and ‘Test’. The Prep-HT-Test ID is to be understood as the ID applied to short samples but maybe applied also to coils. The order of these three parts is designed to agree with the logistics, such that the code will become increasingly complete when passed on. Outstanding parts may be left empty or filled with place holders (‘U’ in case of a letter and ‘0’ in case of a number).

Table 4 Overview of naming scheme for test samples.

| | | | | | | | | | | |
|----------------|--------------------|---|---|---|---|--------|---|---|-----|---|
| | Prep-HT-Test ID → | A | A | A | A | 999999 | A | A | A/9 | 9 |
| Preparation | Preparation Lab | | | | | | | | | |
| | Test Sample ID | | | | | | | | | |
| Heat Treatment | HT Lab | | | | | | | | | |
| | HT Furnace | | | | | | | | | |
| | Date Code | | | | | | | | | |
| | Pull-out Code | | | | | | | | | |
| Test | Test Lab | | | | | | | | | |
| | Test Facility Info | | | | | | | | | |
| | Thermal Cycle ID | | | | | | | | | |

A separate list will be kept by each responsible person to traceably record the details such as:

- for preparation: wire tension for mounting onto I_c barrels, barrel type, etc. (these should be defined in a procedure to which the Manufacturing and Inspection Plan references);
- for HT: ramp rate, temperature, duration, etc.;
- for test: test parameters and criteria.

7.1 Lab Codes

This list applies to 3 characters in the identifier: the Preparation Lab, the HT Lab, and the Test Lab. The full list of suppliers and labs is included in §A.5. For brevity, manufacturers are generically specified as Strand Supplier (S) and Cable Supplier (T) because it is unlikely that one company (say, OST) will sub-contract to another company (say, Bruker) to prepare, heat treat, or test their samples. A named institute has a higher standing and its code should be used in case of conflict, e.g. LBNL as cable manufacturer would retain the code “L” instead of using “T”. In case of complicated situations, Other (O) should be used and further details provided.

Note that pre-HT operations, such as mounting a wire under tension onto a barrel, is considered to be part of the sample preparation operation, whereas post-HT operation, such as soldering voltage taps on I_c barrel samples, is part of the sample testing operation. Information relevant to any operation stage shall be logged on travelers or the strand database.

7.2 Test Sample ID

A character shall identify uniquely multiple samples prepared for one or several tests from the same strand or cable piece (i.e. with the same Strand ID or Cable ID, including the extension part

described in §5 above). Four codes are reserved to specify the low temperature and room temperature tests. See §A.6 for details. For identifying other regularly performed tests not specified in this document, please contact the lead author of this document. The strand piece itself will be identified by the 14-digit strand or cable ID plus the 4-digit extension where appropriate.

7.3 HT Furnace Code

Prior to any heat treatment, this identifier shall be 'U' or omitted to indicate an unreacted state. When designated for heat treatment, a letter or digit shall be assigned by the preparing lab to identify the corresponding furnace. A list of furnace identifiers is to be managed by each lab independently for primarily internal use.

7.4 HT Start Date

The HT start date is a string of digits in the format YYMMDD. Prior to any heat treatment, these characters shall be '000000' or omitted. It is not expected that a furnace will run more than one heat treatment in a day, and therefore the HT Code should be unique by design. If a laboratory is to record its heat treatment internally by serial number instead of date, it is responsible for maintaining a cross-reference list.

7.5 HT pull-out Identifier

Prior to any heat treatment, this identifier shall be 'U' or omitted. When it is necessary to pull a specimen from the furnace before the full reaction heat treatment has completed, pull-outs can be identified by a sequence of letters that denote time-temperature coordinates along a particular profile, e.g. 'A', 'B', 'C', etc. If samples are only taken out at the end of the HT, i.e. the test sample undergoes a complete reaction, the HT Pull-out Identifier *may* be denoted by 'X' instead of 'A'. The particular profile shall be recorded in specimen travelers.

7.6 Test Facility Info

If a lab has multiple facilities, e.g. different magnets for I_c testing, they shall be identified. For a supplier with subcontractors, the facilities at the subcontractor shall be identified as different facilities under the supplier. A list of test facilities (including subcontractors') is to be managed by each lab independently for primarily internal use. Default is '1' when used.

7.7 Thermal Cycle Number

Prior to any testing, this identifier shall be '0' or omitted.

Samples can be tested multiple times. For LARP, cycling between room temperature and cryogenic temperature may impart strain to the sample. Tests that are conducted at cryogenic temperature shall record the number of thermal cycles in this location, starting with '0' for a sample prior to testing. It is not anticipated that a sample will undergo more than 9 thermal cycles.

8 NAME EXAMPLES

8.1 virgin strand name examples

Example 1: PO08S14451A01U – This represents a LARP strand made by OST, rough diameter 0.8 mm (say, 0.85 mm), material Nb₃Sn, billet number 14451, strand production unit ‘A’ (this billet might have processed without breakages), piece Number ‘01’ (this strand production unit might have processed without cuts), un-annealed and un-coated as originally manufactured.

8.2 Cable name examples

Example 1: P23OL1234BB70A – This is a cable sample of a first generation LARP QXF R&D Cable with stainless steel core using un-annealed 108/127 strands (‘P23’) made from OST strands cabled at LBNL (‘OL’), Cable Map 1234, from cable production unit ‘B’, where the point end of the sample was cut at the 170th m = ‘B70’ from the point end of the cable production unit. It is a bare cable (‘A’).

Example 2: P35OL1056AA23E – This is a length of extracted strand corresponding to fork #23 on the cabling machine from a first generation LARP QXF R&D Cable with stainless steel core using annealed 132/169 strands (‘P35’) made from OST strands cabled at LBNL (‘OL’), Cable Map 1056, cable production unit ‘A’, where the sample point end was cut within the first 99 m (‘A’) of the cable. Note that ‘A23’ does NOT denote the position 23 meters from the cable point.

8.3 Test sample name examples

Note: The Virgin Strand ID or Cable ID must be used together with the Prep-HT-Test ID to uniquely identify a short sample. As they are typically barcoded, the hyphenation in the examples below is only as a separator guide to the eye.

Example 1: PO08S14451A01U.PS01-SIUU000000UU00 is a short sample taken from the same strand piece described in §8.1 above. The sample from the point end (‘P’) was cut for supplier use (‘S’). The Prep-HT-Test ID indicates that it is a barrel sample for critical current or RRR test by transport measurement (‘I’) prepared by the strand supplier (‘S’), not yet heat treated, and not yet tested.

Example 2: PO07S14451A02U.XO11-LVLD130531AU00 denotes a short sample taken from the same strand production unit described in §8.1 above but a different piece number (here ‘02’). The test sample was taken from the point end of the strand piece (‘X’, but not ‘P’ because it is not the point end of the billet), with the use designated as other (‘O’, not for supplier or verification activities and not from archive length). It is a straight sample for volumetric or geometric analyses (‘V’) prepared at LBNL, heat treated at LBNL in furnace D in 2013 on May 31st, and taken out of the furnace at the 1st quench position, not intended for tests or not yet tested.

Example 3: Consider the same virgin wire spool described in §8.1 above, that for verification of results, a length long enough for three I_c barrels was cut from the tail end (PO08S14451A01U.YV10 which is to become .YV11, .YV12, .YV13 – see §5.3 above) and wound on a stainless steel mandrel (i.e. prepared) at LBNL and heat treated at BNL in furnace A in 2013 on May 31st. Suppose that after HT, the third sample in this block (.YV13) is to undergo a round-robin J_c test (test ID = ‘I’), first at BNL, then at CERN using test station ‘4’, and finally at LBNL. The Prep-HT-Test ID’s that would be used at BNL, CERN, and LBNL would be, respectively (PO08S14451A01U.YV13-): LIBA1305310AB11, LIBA1305310AC42, LIBA1305310AL13. Here, the 14th character tracks the number of thermal cycles.

A APPENDIX – FULL CODE LIST

A.1 Supplier Code

Note that this table does not necessarily apply to the CDP supplier ID code scheme.

| Strand Supplier | Supplier Code | Description |
|------------------|---------------|---|
| AMSC | A | American Superconductor Corporation, US |
| Alstom | B | Alstom, France |
| Columbus | C | Columbus Superconductors, Italy |
| Luvata Pori | D | Luvata Pori Oy, Finland |
| Bruker EAS | E | Bruker EAS, former Vacuumschmelze, Germany |
| IGC | F | IGC Advanced Superconductors Inc., USA |
| Bruker HTS | H | Bruker High Temperature Superconductor, Germany |
| Hitachi | I | Hitachi for test |
| Sumitomo | J | Sumitomo Corporation, Japan |
| Luvata Fornaci | L | Luvata Fornaci di Barga S.p.A, Italy |
| Luvata Waterbury | M | Luvata Waterbury, USA |
| OST | O | Oxford Superconducting Technology, US |
| SuperPower | P | SuperPower Inc., USA |
| Supercon Inc | Q | Supercon Inc, MA, USA |
| SMI | S | Shape Metal Innovation, Netherlands |
| Hyper Tech | T | Hyper Tech Research, USA |
| Unknown | U | Code for unknown supplier designation |
| WST | W | Western Superconducting Technologies ,China |
| SupraMagnetics | Y | SupraMagnetics, USA |
| Showa | Z | SWCC SHOWA HOLDINGS CO., LTD., Japan |

A.2 Cable Code

| Cable code | DESCRIPTION |
|------------|--------------------------|
| 02 | General LTS R&D w/o Core |

| | |
|-------|--|
| 03 | General LTS R&D w/ Core |
| 12 | HD/LD R&D w/o Core |
| 13 | HD/LD R&D w/ Core |
| 14 | TQ/LQ R&D w/o Core |
| 15 | TQ/LQ R&D w/ Core |
| 16 | HQ/LHQ R&D w/o Core |
| 17 | HQ/LHQ R&D w/ Core |
| 18 | HQ2/LHQ2 R&D w/o Core |
| 19 | HQ2/LHQ2 R&D w/ Core |
| 22 | QXF R&D w/o Core, using un-annealed 108/127 wires |
| 23 | QXF R&D w/ Core, using un-annealed 108/127 wires |
| 24 | QXF R&D w/o Core, using un-annealed 132/169 wires |
| 25 | QXF R&D w/ Core, using un-annealed 132/169 wires |
| 26 | QXF R&D w/o Core, using un-annealed 144/169 wires |
| 27 | QXF R&D w/ Core, using un-annealed 144/169 wires |
| 32 | QXF R&D w/o Core, using annealed 108/127 wires |
| 33 | QXF R&D w Core, using annealed 108/127 wires |
| 34 | QXF R&D w/o Core, using annealed 132/169 wires |
| 35 | QXF R&D w/ Core, using annealed 132/169 wires |
| 36 | QXF R&D w/o Core, using annealed 144/169 wires |
| 37 | QXF R&D w/ Core, using annealed 144/169 wires |
| 40-59 | Same as 20-39, but for '2 nd generation' QXF cables |
| 60-79 | Currently unassigned |
| 80-89 | LTS Production, using un-annealed wires |
| 90-99 | LTS Production, using annealed wires |

Note: even number codes = no stainless steel core, odd number codes = with core.

A separate list has to be kept for the cabling parameters.

A.3 Cable Manufacturer Code

| Cable Manufacturer | Supplier Code | Description |
|--------------------|---------------|--|
| Babcock Noell | B | Babcock Noell GmbH |
| CERN | C | European Organization for Nuclear Research |
| LBNL | L | Lawrence Berkeley National Laboratory |
| NEWT | N | New England Wire Technologies |

A.4 State of Cable/Strand

| State of Cable/Strand | Code | Description |
|-----------------------|------|---|
| Bare (Cable) | A | Bare cable |
| Braided (Cable) | B | Cable with braided insulation |
| Copper (Strand) | C | Cu strand |
| Extracted (Strand) | E | extracted strand |
| SS Core | S | Extracted stainless steel core |
| Taped (Cable) | T | Cable with tape insulation |
| Virgin (Strand) | V | Leftover virgin strand on the cabling machine attached to the cable at the end of the cabling run |

A.5 Lab Code entries for preparation, HT, and test specimens

| HT Lab | HT Lab Code | Description |
|---------------|-------------|---|
| ASC/FSU/NHMFL | A | Applied Superconductivity Center at FSU/NHMFL |
| BNL | B | Brookhaven National Laboratory |
| CERN | C | European Organization for Nuclear Research |
| FNAL | F | Fermilab |
| LBNL | L | Lawrence Berkeley National Laboratory |
| NIST | N | National Institute of Standards and Technology |
| Other | O | Other/one-off situations (further details required) |
| OSU | R | Ohio State University |
| Supplier | S | Supplier (Wire manufacturer) or its subcontractors |
| Supplier | T | Supplier (Cable manufacturer) or its subcontractors |

| | | |
|------------|---|------------------|
| Unassigned | U | Not yet assigned |
|------------|---|------------------|

A.6 Test Sample ID

| Test ID | Description |
|---------|--|
| I | Barrel sample for critical current or RRR test by transport measurement |
| O | Other (further details required) |
| M | Small coil sample for magnetization width measurements |
| R | Straight sample for RRR by transport measurement |
| V | Sample for volumetric or geometric analyses (e.g. Cu:non-Cu ratio, twist pitch, diameter etc.) |

A.7 Thermal Cycle Number

| Sample Configuration | Test Info | Description |
|----------------------|-----------|--------------------------|
| Thermal cycle | 0-9 | Number of thermal cycles |